

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



for
ELECTRICAL POWER PRODUCTION
(3E0X2)

MODULE 12

**ELECTRICAL POWER PRODUCTION TOOLS, TEST
EQUIPMENT AND HARDWARE**

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Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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INTRODUCTION

Before starting this AFQTP, refer to and read the “Trainee/Trainer Guide” located on the AFCEA Web site <http://www.afcesa.af.mil/>. This guide will be found at each AFS’s AFQTP download page.

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. *It is important for the trainer and trainee to understand* that an AFQTP does not replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification using the included Performance Checklist

Diamond task:

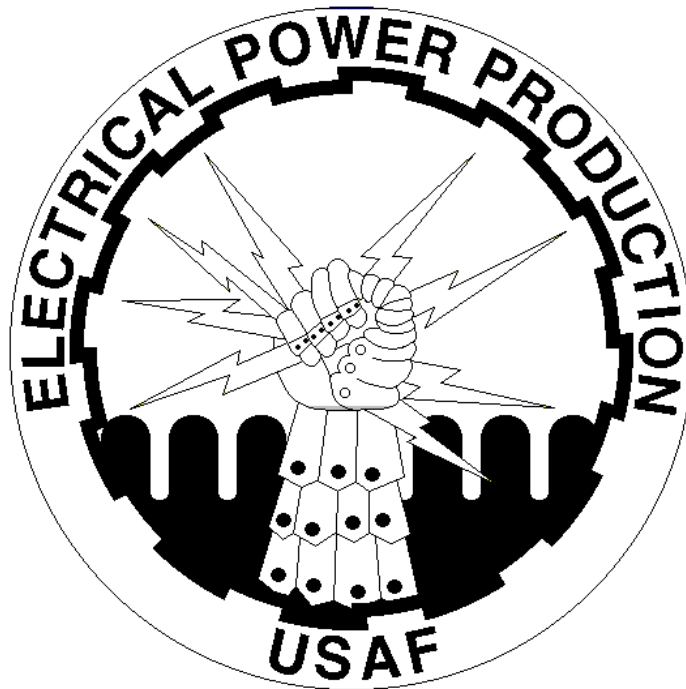
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification using the included Performance Checklist when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCEA/CEOT revised this AFQTP. If you have any recommendations for improving this document, please contact the Electrical Power Production Career Field Manager at the address below.

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ELECTRICAL POWER PRODUCTION TOOLS, TEST EQUIPMENT AND HARDWARE

MODULE 12

AFQTP UNIT 1

USE HAND TOOLS (12.1.)

Notice. This AFQTP is NOT intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

USE HAND TOOLS

Task Training Guide

STS Reference Number/Title:	12.1., Use Hand Tools
Training References:	<ul style="list-style-type: none"> AFIs 32-1031; 32-1044; T.O.s 32, 33, 34, 35 Series
Prerequisites:	<ul style="list-style-type: none"> Possess as a minimum a, 3E032 AFSC.
Equipment/Tools Required:	<ul style="list-style-type: none"> Personal Protective Equipment (PPE) Tools: screwdrivers, punches, chisels, files, hacksaws, hammers, pliers, wrenches, mechanical fingers inspection mirrors, gages and a portable electric drill
Learning Objective:	<ul style="list-style-type: none"> Identify and properly use tools, associated with the Electrical Power Production career field
Samples of Behavior:	<p>The trainee should know how to:</p> <ul style="list-style-type: none"> Identify different types of tools Safely and effectively use assorted tools
Notes:	
<ul style="list-style-type: none"> Any safety violation will result in failure. Trainer will demonstrate and test trainee on various applications to insure safe practices. 	

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USE HANDTOOLS

Background: You need to be able to identify and be familiar with some of the most commonly used handtools in order to be an efficient electrician. The screwdriver may be the most used and also most abused handtool that you will use. The abuse results when the wrong type screwdriver has been selected or it is used for a chisel or prybar. Also, when you turn a screw, never use pliers on the blade-- force to the handle with your hand should work. There are two main types of screwdriver blades: the crosspoint and the standard (common) blade. Figures 1 and 2 below show different types and proper uses of screwdrivers.

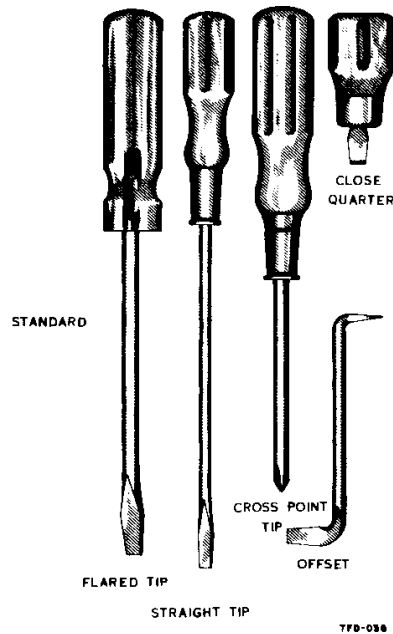


Figure 1, Screwdrivers

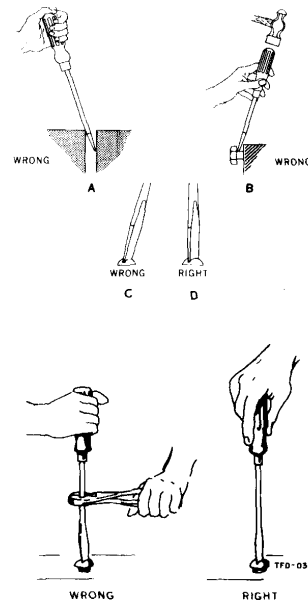
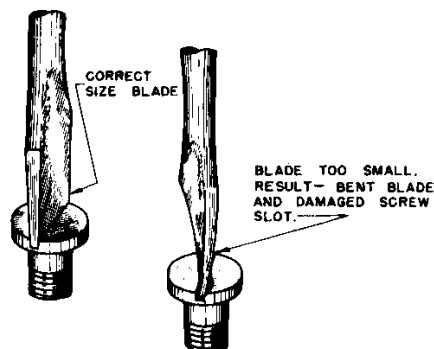


Figure 2, Use of Screwdrivers

When selecting a screwdriver, make sure the screwdriver fits the screw. If the blade is too small, you will either damage the blade or damage the slot in the head. See Figure 3 for proper selection examples. After extended use, even when used properly, it will become necessary to ground or file the screwdriver blade tip to restore it. After filing, the sides should still be parallel to keep them firmly in the screw slot. In Figure 4 the correct way to grind a screwdriver blade tip is shown. A three cornered file is used to remove nicks and burrs from a crosspoint screwdriver.



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Figure 3, Blade Fit (Thickness)

Pliers are also very common handtool's for the electrician. Figure 5 shows some of the more common types including: diagonals, sidecutters (lineman's pliers), longnose (needle nose), combination slip-joint and water pump (channel-locks). Diagonals and sidecutters are used mainly for cutting wire. Diagonals work well for close cutting, while larger wire demands the use of the sidecutters. Sidecutters also work well for bending and twisting wire. Combination slip-joint and water pump pliers are adjustable to various sizes and both have long handles for extra gripping power. They are excellent tools when you're running conduit, especially when you're using raintight fittings. Longnose pliers are used for bending loops in solid wire when you need to place it under a bolthead or screwhead. Or, if your fingers aren't quite long enough, they can be used to place or tighten wires. Pliers are not intended to be an all-purpose tool. You will round the corners on nuts and bolts if pliers are used for tightening them. Never use pliers as a hammer or prybar because you may break the handles. Good judgment should be used when selecting the right set of pliers for the job. The proper size must be selected or you will be in danger of breaking the tool. The care of pliers usually calls for a drop or two of oil at the pivot point and the filing of the cutting edges with a fine file when the edge becomes pitted.

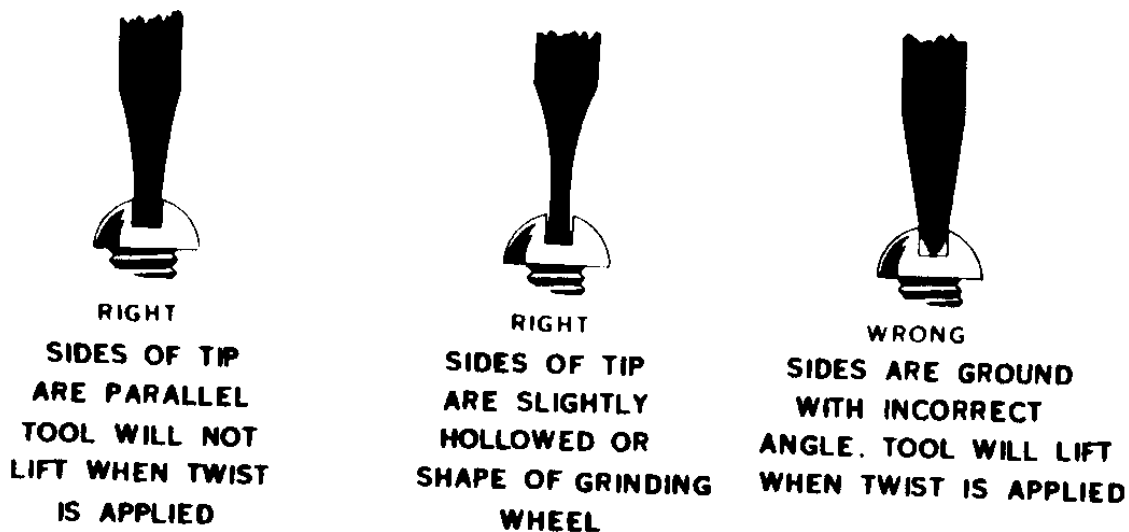


Figure 4, Blade tip shape

The hacksaw and knockout punch are two types of cutting tools used by electricians. Most hacksaws have frames that can be adjusted for different blades, which vary in length from 8 to 16 inches (See Figure 6). These blades differ by hardness and number of teeth per inch. A hard blade with 18 teeth or less is good for cutting hard metals such as rigid conduit, while a flexible blade with 24 teeth or more is good for cutting soft metals such as electrical metallic tubing (EMT). After selecting the correct blade, put it in the frame with the point of the teeth aimed away from the handle. Sawing is done by taking a light, steady, forward stroke. The weight of the saw will cause the blade to bite into the metal, no need to bear down and risk breaking the blade and possible injury. Keep the hacksaw clean and replace the blade when it becomes dull or broken.

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Next is the knockout punch, it is used for enlarging holes in panels, boxes and steel cabinets and will cut metal up to 1/8 of an inch thick (See Figure 7). Stamped on the side of the punch is the diameter of the hole it will cut. For example, if you are using 2-inch conduit you will need a punch that cuts a 2 3/8-inch diameter hole. Punches range from 1/2 inch conduit size all the way up to 4-inch conduit size. Before you can use the tool, you must have a hole in the metal to be punched. The size of the hole is determined by the size of the punch used. The drivebolt for the 1/2-inch conduit punch requires a 3/8-inch hole. The drivebolt for 3/4-inch conduit or larger requires a 3/4-inch hole. Regardless of the size conduit being used, drill a 3/8-inch hole first. If conduit larger than 1/2-inch is being used, punch the hole needed for 1/2-inch conduit, then you will have the 3/4-inch hole needed for the larger drivebolt. Insert the drivebolt through the top part (die) of the knockout and then through the hole in the box. Next you thread the bottom part (punch) onto the drivebolt ensuring the die and punch is secure against the box. Use a wrench to turn the drivebolt to punch the hole. Don't get in too big of a hurry, give the punch time to cut through the metal, the hole will have smoother edges and the punch will remain in better shape. Next, you will hear two snaps of the metal and then the slug should be free of the box. After removing the tool from the work you may need to tap the slug to free it from the die. The knockout punch will last for many years if it is kept clean and well oiled.

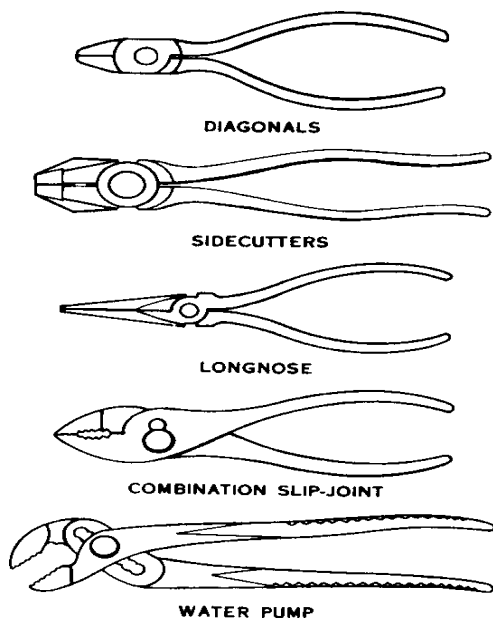


Figure 5, Pliers

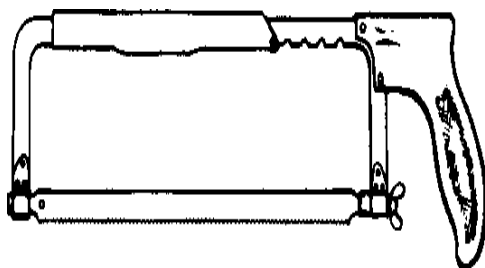


Figure 6, Hacksaw

Wrenches of various kinds are used while performing electrical work. Some for turning square materials such as nuts and bolts and some for turning round materials such as conduits. Figure 8 shows some commonly used wrenches.

Pipe Wrench. The pipe wrench uses a knurled wheel to adjust the space between the jaws. The movable jaw is spring loaded and will bind or lock when it pulls on a pipe. A pipe wrench comes in handy when you are working with rigid conduit or when large sizes of EMT are being used and the fittings are too big for channel-lock pliers.

Adjustable Open End Wrench. The adjustable open end wrench has a spiral drive wheel for jaw adjustment and the jaws should fit firmly on a nut to prevent the wrench from slipping and damaging the nut.

Open End Wrench. Open end wrenches are convenient when working space is limited because they can be turned over after each movement. The length varies with the size of the opening. If space is not a problem, the box end wrench is used because it is not as likely to slip off the nut or bolthead. It cannot be used on a square nut, only on hexagon nuts and boltheads.

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Strap Wrench. The strap wrench has a thick canvas strap to grip the pipe when you don't want the finished surface to be scratched or marred.

Chain Wrench. The chain wrench is placed on the pipe by wrapping the chain around the pipe and then attaching the chain in a slot on the wrench. Two advantages of the chain wrench is that it applies pressure evenly around the entire pipe and that it is not likely to slip off the pipe.

When using a wrench of any kind, try to pull, don't push on it. The correct way to use open end wrenches is shown in Figure 9. If an adjustable jaw wrench is being used, don't apply the pulling force to the adjustable jaw. It will likely slip or break the wrench. Figure 10 shows the right and wrong way to use an adjustable end wrench. Never use a pipe (cheater) over the handle to increase leverage because this may bend or break the handle. Finally, remember the advantages and disadvantages of all the wrenches. A good electrician will not only select the best wrench for the job but also the correct wrench size, as shown in Figure 11. Keep your wrenches clean and rust free. Wipe them down occasionally with a clean cloth and light grade oil. Use a few drops of oil on the drive wheel of the adjustable jaw wrenches. When a wrench becomes battered and defective, take it out of service.

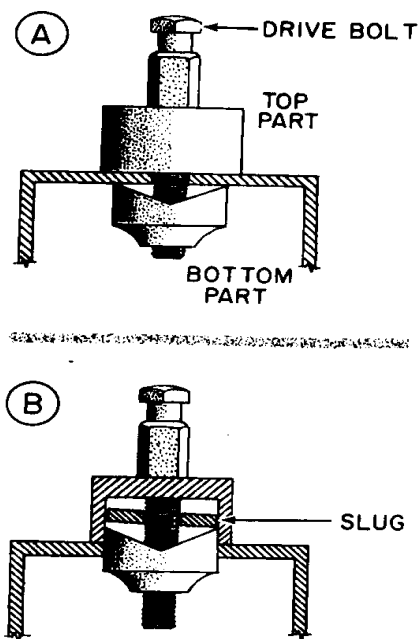


Figure 7, Knockout Punch

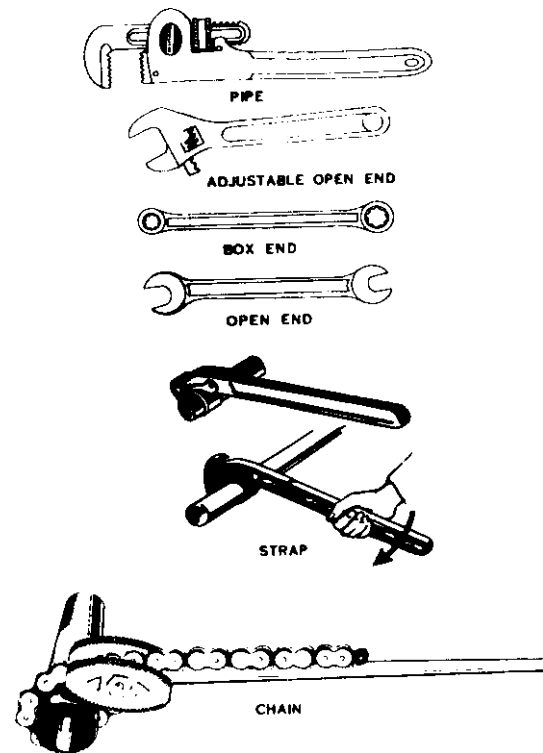


Figure 8, Wrenches

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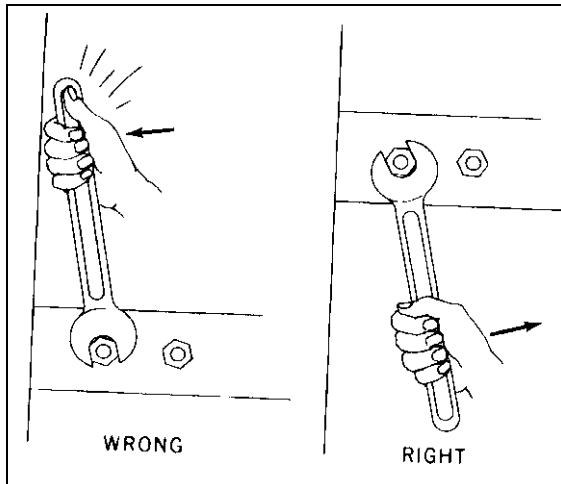


Figure 9, Proper use of Open End Wrenches

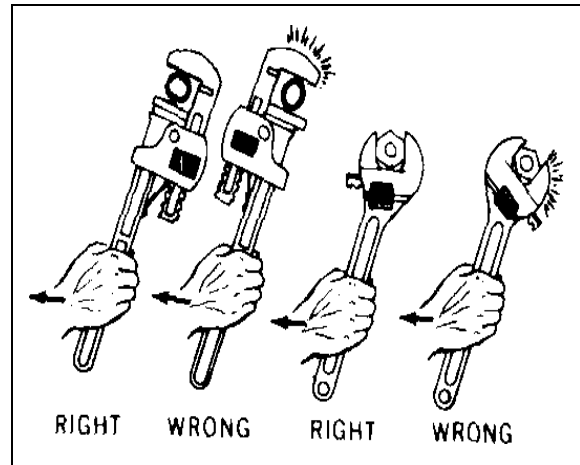


Figure 10, Proper use of Adjustable Jaw Wrenches

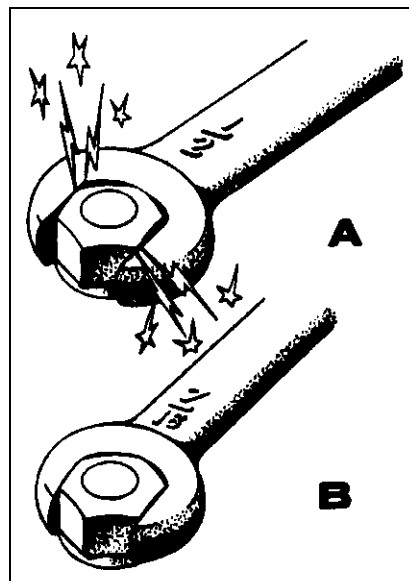


Figure 11, Selecting Correct Wrench Size

HINT:

Within normal workload constraints, set aside sufficient time to work on the package. Studies into effective training programs indicate that the best trainees reserve the same time each day to complete their study. Pace yourself, establish a schedule, and stick to it. Give yourself top priority to become qualified.

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Review Questions
for
Use Handtools

Question	Answer
1. Never use a screwdriver as a chisel or Prybar.	a. True b. False
2. Which type pliers would be used to cut larger types of wire?	a. Diagonals b. Longnose c. Sidecutters d. Waterpump
3. A flexible hacksaw blade with 24 teeth or more would be best for cutting electrical metallic tubing.	a. True b. False
4. The drivebolt for the ½ inch conduit punch requires what size hole?	a. ½ inch hole b. 3/8 inch hole c. 5/8 inch hole d. ¾ inch hole
5. Which tool should you use to turn the drivebolt to punch a hole?	a. Channel-lock pliers b. Wrench c. Needle nose pliers d. Sidecutters
6. The hole you punch will have smoother edges if you give the punch time to cut.	a. True b. False
7. Which tool would you use to remove a coupling from a piece of 2 inch rigid conduit?	a. Adjustable open end wrench b. Box end wrench c. Pipe wrench d. Open end wrench
8. If space is not a problem, which tool would you use to tighten a nut onto a bolt?	a. Open end wrench b. Box end wrench c. Strap wrench d. Pipe wrench
9. A box end wrench can only be used on hexagon nuts and boltheads.	a. True b. False
10. Which one of the four statements is false.	a. Screwdrivers should always fit the screw b. Pliers can sometimes be used as hammer c. Knockout punch used for enlarging holes d. Good electricians will select the best tool for the job
11. As a general rule, which of the following statements would be true.	a. Pliers are not intended to be an all-purpose tool b. When using a wrench of any kind try to pull the wrench toward you c. Always keep your handtools clean and well oiled d. All of the above

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USE HAND TOOLS

Performance Checklist		
Step	Yes	No
1. Can trainee identify most commonly used electrical handtools?		
2. Does the trainee know how to take care of his/her tools.		
3. Does the trainee know what to do with battered and defective tools.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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USE PORTABLE POWER TOOLS***Task Training Guide***

STS Reference Number/Title:	24.3. – Tools and equipment, use portable power tools
Training References:	<ul style="list-style-type: none"> • CDC 3E051A Vol. 4
Prerequisites:	<ul style="list-style-type: none"> • Possess as a minimum a 3E031 AFSC.
Equipment/Tools Required:	<ul style="list-style-type: none"> • General Tool box • Personal safety equipment
Learning Objective:	<ul style="list-style-type: none"> • Given equipment, use portable power tools
Samples of Behavior:	<ul style="list-style-type: none"> • Follow approved methods to use an electric hand drill • Follow approved methods to use a rotary hammer • Follow approved methods to use a saber saw • Know safety requirements to use portable power tools
Notes:	
<ul style="list-style-type: none"> • To successfully complete this element follow the steps outlined in the applicable technical manual exactly—no exceptions. • Any safety violation is an automatic failure. 	

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USE PORTABLE POWER TOOLS

Background: There are many portable power tools available today, but the three most often used by electricians are the electric hand drill, the rotary hammer, and the saber saw.

The process of drilling holes in metal with an electric drill is similar to that of drilling them by hand except the turning of the drill is done by an electric motor instead of the operator. Drills come in several sizes. The drill size is determined by the largest drill bit that will go in the jaws of the drill. The drills usually come with either a pistol grip or Closed handle (spade grip), depending on the size of the drill. The bits are secured in the jaws of the drill by a key-type gear chuck. An example of a typical electric hand drill is shown in Figure 1.

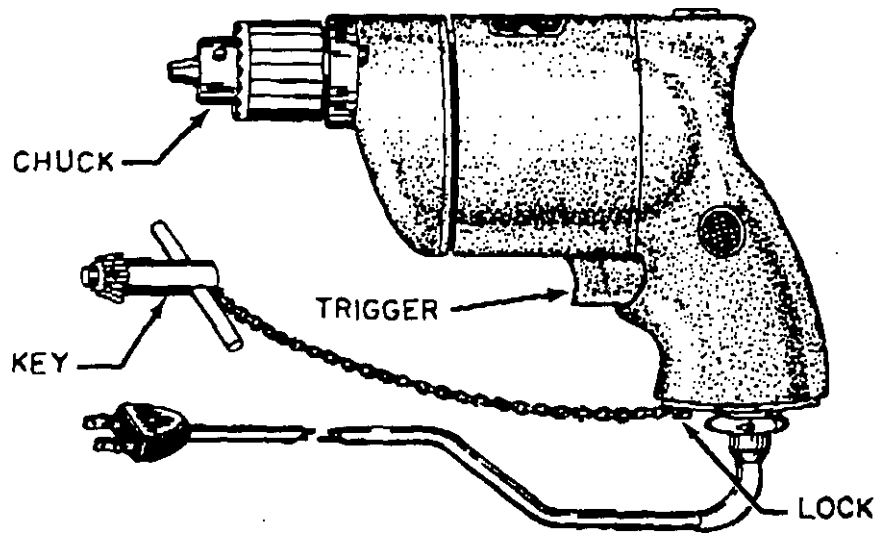


Figure 1, Portable Electric Drill

Three of the most common type bits used in the electric drill are the twist bit, spade bit, and the masonry bit, shown in Figures 2 and 3. The twist bit can be used for drilling wood or metal and is the bit that you will use most often. Center punch the spot to be drilled to prevent the bit from running. When drilling with the twist bit, reduce the pressure just before breaking through the metal and this will prevent the bit from hanging up and possibly jerking the drill out of your hands. The spade bit is used for drilling wood. Since the spade bit does not have a screw tip, pressure will have to be applied for starting and drilling. Slack off a little on the pressure when the point of the spade bit breaks through the wood to keep from splintering the material. The masonry bit is used for drilling concrete, cinder block and brick. Masonry bits come in several sizes and while they may be used in a normal electric drill for light construction work, in most cases they will be used in a rotary hammer.

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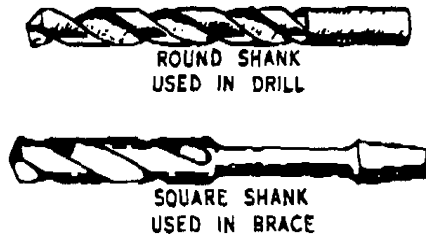


Figure 2, Twist Bits

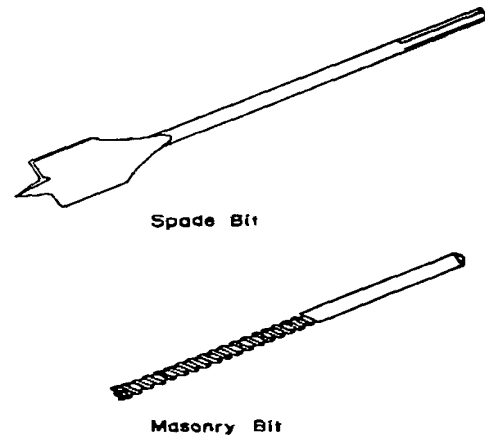


Figure 3, Spade and Masonry Bits

The rotary hammer is a portable power tool that is used most often when you have holes to drill in masonry. The rotary hammer looks just like an electric drill but it is made of heavier construction. Because it drills and hammers the bit simultaneously, even the strongest concrete can be penetrated. The rotary hammer will perform the best if only a light amount of pressure is applied to the handle.

The saber saw (shown in Figure 4) is another portable power tool that you will soon become familiar with. It is used when an opening is needed to install a box for a switch or receptacle in a finished drywall or you may need to notch a stud when running cable. Several types of blades are available depending on the material that you are cutting. To cut an opening in a finished wall, first drill a pilot hole inside the area to be cut out. Then put the blade of the saw into the hole and hold the base plate firmly against the wall before starting to cut.

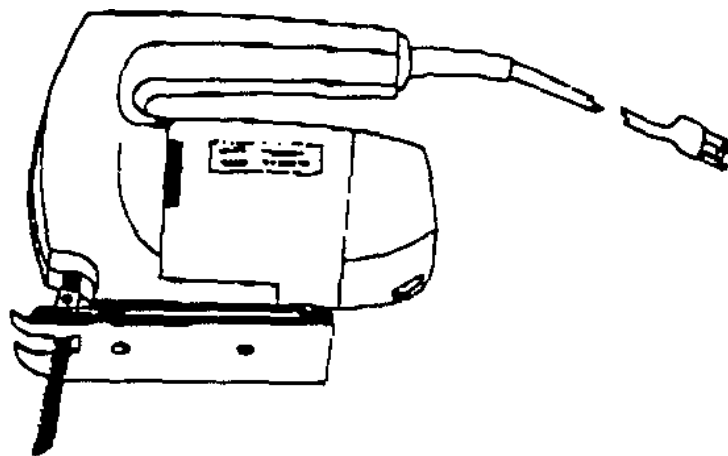


Figure 4, Saber Saw

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A few things to remember when using portable power tools.

- In most cases, light even pressure is all you need for the tool to do its job. Apply too much pressure and the power tool will stall and overheat.
- Ventilation holes on power tools must be kept clean to prevent the power tool from overheating. You must also avoid putting your hands over the ventilation holes when applying pressure while drilling or cutting. The power tool must have this ventilation to operate properly.

NOTE:

Before you cut or drill into a finished wall check to make sure that you are not going to damage something that is already in the wall, there could easily be something concealed right where you want an opening.

SAFETY:

Always wear eye protection when using any portable power tool and if you will be stirring up dust when you work, wear a mask to protect your nose and throat.

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Review Questions for Use Portable Power Tools

Question	Answer
1. Size of the drill is determined by the largest drill bit shank that will go in the jaws of the drill.	a. True b. False
2. A spade bit is used for drilling what type material?	a. Concrete b. Wood c. Metal d. Brick
3. A masonry bit is used <i>for drilling</i> what type of material?	a. Cinder block b. Brick c. Concrete d. All of the above
4. The electric hand drill is made of heavier construction than the rotary hammer.	a. True b. False
5. The rotary hammer drills and hammers simultaneously.	a. True b. False
6. Which saw would be best for cutting an opening in a finished wall?	a. Skilsaw b. Hacksaw c. Saber saw d. None of the above
7. Ventilation holes must be kept clean to prevent power tools from overheating.	a. True b. False
8. Tight even pressure is all you need to operate most portable power tools.	a. True b. False
9. Applying too much pressure to the portable power tool will stall or overheat it.	a. True b. False
10. Always make sure there is nothing in the wall before drilling or cutting.	a. True b. False
11. When using a rotary hammer you may need to use a mask to protect your nose and throat from dust.	a. True b. False

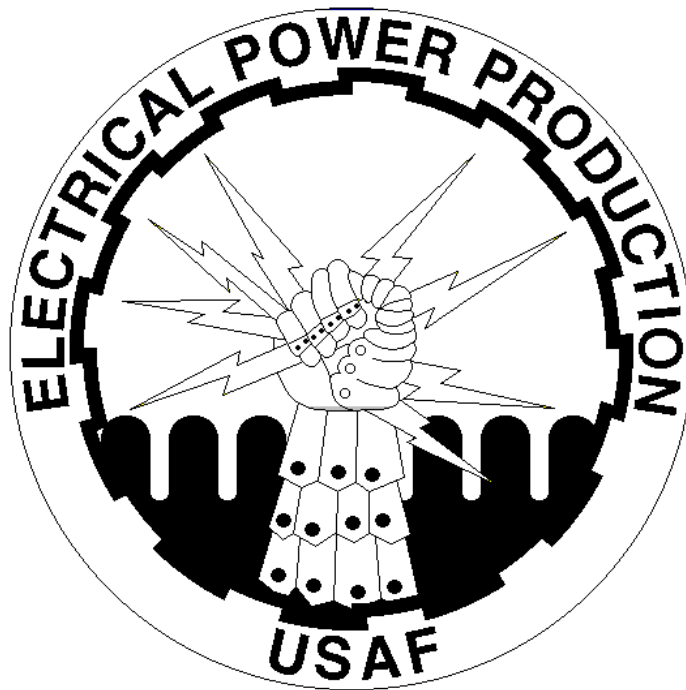
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USE PORTABLE POWER TOOLS

Performance Checklist		
Step	Yes	No
1. Can trainee identify most commonly used portable power tools.		
2. Does the trainee know how to take care of portable power tools.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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ELECTRICAL POWER PRODUCTION TOOLS, TEST EQUIPMENT AND HARDWARE

MODULE 12

AFQTP UNIT 4

USE ELECTRICAL TEST EQUIPMENT (12.4.)

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USE ELECTRICAL TEST EQUIPMENT

Task Training Guide

STS Reference Number/Title:	12.4., Use electrical test equipment
Training References:	<ul style="list-style-type: none"> • CD-ROM, (Power Production Test Equipment) • Technical Order (T.O.) 33A12-12-651-1, For Simpson 260 Multimeter • T.O. 33A1-12-1300-1 for; Fluke Digital Multi-meter • T.O. 33A1-12-1300-1C Supplement to the aforementioned T.O. 33A1-4-5-11 for the PSM1/A and PSM2/A hand-crank • T.O. 33A1-12-687-1 for model 263 and 293
Prerequisites:	Possess as a minimum a, 3E032 AFSC
Equipment/Tools Required:	<ul style="list-style-type: none"> • Multimeter • Clamp-on ammeter • Phase rotation meter • Megohmmeter • 3 Phase power source
Learning Objective:	<ul style="list-style-type: none"> • Proper application and functions of: Multi- Meter, Ammeter, Megohmmeter and Phase Rotation Meter <ul style="list-style-type: none"> • Properly identify the different types of meters • Properly connect meters to electrical circuits • Measure and test electrical circuits
Samples of Behavior:	<ul style="list-style-type: none"> • Determine when and how to use the various electrical test equipment: <ul style="list-style-type: none"> • Multi-meter • Clamp-on Ammeter • Megohmmeter • Phase Rotation • Identify and operate the various functions on electrical test equipment • Safely and accurately operate the various meters
Notes:	<ul style="list-style-type: none"> • Any safety violation will result in failure • Trainer will demonstrate and test trainee on various applications to insure safe operations • TRAINER NOTE: If more than one type of meter is available you must train on all meters.. If your base does not have various meters, train on the ones available and, if possible, order required meters. • TRAINER NOTE: Your equipment may vary. Use this as a teaching guide to insure trainee can successfully operate all the meters used in this course.

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USE ELECTRICAL TEST EQUIPMENT

Background: There are many different types of electrical meters, all of them are important tools for the maintenance and troubleshooting of electrical equipment and circuits. The construction features may be slightly different for different brands of meters but the theory of operation is essentially the same. For example all analog multimeters consist of a meter coil, a means of selecting a function, (A/C, D/C, Mil Amp, and so forth), a means of selecting the range or scale of measurement (0.5to 1000), and a scale which shows the value of measurement. Digital meters operate in the same manner. We need to understand their uses and differences to ensure we interpret their readings correctly to be effective with our mission. Many accidents occur while taking meter readings resulting in personal injury or equipment damage, therefore we must understand the operation and ensure all safety procedures are followed. The ability to select the correct type of electrical meter for the application required is no easy task without proper training. Serious injury or death can result from improper meter selection. Some meters produce a high voltage themselves and other will be used to measure high voltages, so the possibilities for danger are always present. We must perform with confidence and safely, in all environments and conditions.

To accomplish this lesson, complete CD-ROM, Power Production Test Equipment

NOTE: After completing all the lessons you may see your Unit Education and Training Manager to take the following optional Certest:

<u>Test no.</u>	<u>Title</u>
8089	Test Equipment

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USE ELECTRICAL TEST EQUIPMENT

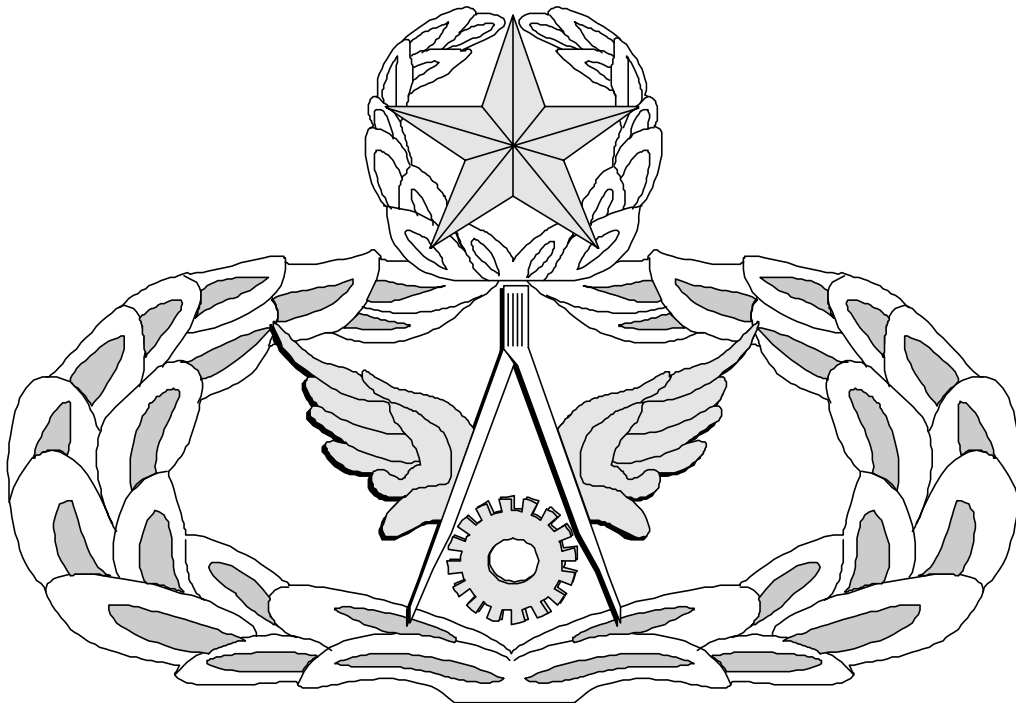
Performance Checklist		
Step	Yes	No
Multi-meter:		
1. Knew the three different functions of a multi-meter.		
2. Properly set-up the multi meter.		
3. Selected proper range scale.		
4. Properly connected meter to the circuit to be tested. (proper polarity if applicable)		
5. Properly interpreted the indicated meter reading.		
6. Ensured when testing in the "OHM" function; the circuit had been de-energized. (Ref. to questions 1,2, & 4)		
7. Properly connected the ammeter to the circuit. (Ref. To the clamp-on ammeter checklist)		
8. Followed all safety procedures		
Clamp-on Ammeter:		
1. Understands the purpose of an ammeter.		
2. Properly set-up the ammeter.		
3. Selected proper range scale.		
4. Properly interpreted the indicated meter readings.		
5. Properly took readings for multiple parallel conductors.		
Followed all safety procedures		
Phase Rotation Meter:		
1 Understands purpose of phase rotation meter		
2. Properly connected meter to the circuit to be tested. (i.e. Red, White and Blue)		
3. Properly interpreted the phase rotation meter reading.		
Megohmmeter:		
1. Explained the uses and purpose of a Megohmmeter.		
2. Knows the general safety procedures associated with use of the Megohmmeter.		

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3. Properly set-up the meter. (red to 'L', black to 'GRD')		
4. Established proper location for test electrodes. (red to a lead, black to the frame)		
5. Properly read the resistance on the calibrated ohm scale.		
6. Discharged leads between each test.		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer
QUALIFICATION TRAINING PACKAGE (QTP)
REVIEW ANSWER KEY



For
ELECTRICAL POWER PRODUCTION

(3E0X2)

MODULE 12
ELECTRICAL POWER PRODUCTION TOOLS AND TEST
EQUIPMENT

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Key-1

USE HANDTOOLS

(3E0X2-12.1.)

Question	Answer
1. Never use a screwdriver as a chisel or prybar.	a. True
2. Which type pliers would be used to cut larger types of wire?	c. Sidecutters
3. A flexible hacksaw blade with 24 teeth or more would be best for cutting electrical metallic tubing.	a. True
4. The drivebolt for the ½ inch conduit punch requires what size hole?	b. 3/8 inch hole
5. Which tool should you use to turn the drivebolt to punch a hole?	b. Wrench
6. The hole you punch will have smoother edges if you give the punch time to cut.	a. True
7. Which tool would you use to remove a coupling from a piece of 2 inch rigid conduit?	c. Pipe wrench
8. If space is not a problem, which tool would you use to tighten a nut onto a bolt?	b. Box end wrench
9. A box end wrench can only be used on hexagon nuts and boltheads.	b. False
10. Which one of the four statements is false.	b. Pliers can sometime be used as hammer
11. As a general rule, which of the following statements would be true.	d. All of the above

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USE PORTABLE POWER TOOLS

(3E0X2-12.1.)

Question	Answer
1. Size of the drill is determined by the largest drill bit shank that will go in the jaws of the drill.	a. True
2. A spade bit is used for drilling what type material?	b. Wood
3. A masonry bit is used <i>for drilling</i> what type of material?	d. All of the above
4. The electric hand drill is made of heavier construction than the rotary hammer.	b. False
5. The rotary hammer drills and hammers simultaneously.	a. True
6. Which saw would be best for cutting an opening in a finished wall?	c. Saber saw
7. Ventilation holes must be kept clean to prevent power tools from overheating.	a. True
8. Tight even pressure is all you need to operate most portable power tools.	a. True
9. Apply too much pressure and the portable power tool will stall or overheat.	a. True
10. Always make sure there is nothing in the wall before drilling or cutting.	a. True
11. When using a rotary hammer you may need to use a mask to protect your nose and throat from dust.	a. True

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